Management and predictors of clinical events in 75 686 patients with acute myocardial infarction

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DOI: 10.33963/KP.a2022.0058

Received:
August 19, 2021

Accepted:
February 21, 2022

Early publication date:
February 21, 2022

ABSTRACT

Background: Although mortality in patients with acute myocardial infarction (MI) has decreased substantially over the last few decades in many countries, MI remains a major threat to public health.

Aims: To assess the number and outcomes of patients hospitalized for acute MI in Poland in 2018 as well as proportions of patients participating in cardiac rehabilitation and undergoing invasive cardiac procedures following discharge.

Methods: We used public databases. We included all patients hospitalized for acute MI in Poland in 2018 and assessed event-free survival along with uptake of invasive cardiac procedures, cardiac rehabilitation, and consultations with cardiologists.

Results: A total of 75868 patients (mean age, 68.8 years) were hospitalized for acute MI in Poland in 2018 (the admission rate, 197.0 per 100000 inhabitants). In-hospital mortality was 8.4%, while one-year mortality was 17.3% (one-year post-discharge mortality was 9.8%). Approximately 75% and 96% of discharged patients consulted a general practitioner, whereas 12% and 62% consulted a cardiologist, 5% and 19% underwent percutaneous coronary intervention, 0.6% and 2.9% underwent coronary artery bypass grafting, while 0.04% and 1.9% had an implantable cardioverter defibrillator implanted within 30 days and 365 days following discharge. The participation rate in cardiac rehabilitation within the first 14 days following discharge was 11%, within the first 30 days was 19%, and within 365 days was 35%.

Conclusions: In-hospital and post-discharge mortality is still high in Poland. The access to cardiac consultations and cardiac rehabilitation following MI is insufficient. There is considerable potential for a further decrease in mortality in patients suffering from MI in Poland.

Key words: cardiac rehabilitation, cardiovascular events, coronary artery disease, mortality, myocardial infarction

WHAT'S NEW?

We found that in 2018, 75 868 patients were hospitalized for acute myocardial infarction (MI) in Poland. This means a decrease compared to previously published estimates for 2012. The admission rate was 197.0 per 100 000 inhabitants: 255.2/100 000 among men and 142.5/100 000 among women. Among patients hospitalized for acute myocardial infarction in 2018, in-hospital mortality was 8.4%, while one-year mortality (counted starting from the admission to the hospital) was 17.3%, and one-year post-discharge mortality was 9.8%. These estimates are considerably lower compared to 2009–2010. Approximately 75% of discharged patients consulted a general practitioner, and 12% consulted a cardiologist within 30 days (37% within 90 days) following discharge. About 16% of MI survivors underwent percutaneous coronary intervention and 2.5% underwent coronary artery bypass grafting within the first 180 days, while 1.4% had an implantable cardioverter defibrillator implanted.

INTRODUCTION

Although mortality in patients with acute myocardial infarction (MI) has decreased substantially over the last few decades in many countries, MI remains the most serious complication of coronary artery disease [1, 2]. Several countries, including France, Japan, Korea, Poland, Sweden, and the United Kingdom have presented nationwide population-based studies [3–4]. The recent report from a countrywide population-based study analyzed the data of patients hospitalized for MI from 2009 to 2012 [3]. In addition, several reports analyzing subgroups of MI patients have also been published [2, 5–6]. Recently, an analysis of long-term outcomes of acute MI survivors was published [7]. There is convincing evidence of temporal changes in risk factor control as well in the invasive and non-invasive management of patients with MI in Poland since 2012 [8–9]. Therefore, the present study aimed to assess the number of patients hospitalized for acute MI in 2018 in Poland, in-hospital mortality, event-free survival following discharge, predictors of clinical events, and proportions of patients participating in cardiac rehabilitation programs and undergoing invasive cardiac procedures following discharge.

METHODS

We included all adult patients hospitalized for acute MI in Poland between January 1, 2018 and December 31, 2018 and reported to the National Health Fund database. We included all patients with reported ST-elevation MI, non-ST-elevation MI, and unspecified MI (see Supplementary material, *Table S1*). The study population consisted of patients who experienced acute MI for the first time during the study period, irrespective of a history of MI in the past. We analyzed only records of patients with Polish personal identification numbers (PESEL).

A patients' history was determined using data from the National Health Fund. A patient was coded as having a disease (e.g. diabetes or heart failure) if the disease was reported by any hospital or outpatient clinic to the National Health Fund database. The department classifications were based on the Polish Ministry of Health data. Survival was determined according to the national database of deaths (Central Statistical Office). Consultations with cardiologists and general practitioners and recurrent hospitalizations, including hospitalizations for acute MI, stroke, and invasive cardiac procedures, were determined using the National Health Fund database. Hospitalization was defined as admission to a health care facility lasting >24 hours unless the patient died within 24 hours. The index hospitalization for MI was defined as a continuous hospital stay, including all possible transfers between wards or hospitals for any reason until a patient's discharge home or death. If the time delay between hospital discharge and the subsequent admission for MI was ≤1 day, both admissions were considered due to the same MI.

Ethics committee approval was not needed as the authors analyzed the national database. Informed consent was not required.

Endpoints

The primary endpoint was defined as death from any cause, whereas secondary endpoints were (1) all-cause death or myocardial infarction or stroke; and (2) all-cause death or hospitalization for any cardiovascular disease.

Statistical analysis

Continuous variables are presented as means (standard deviations [SD]) or medians (interquartile ranges [IQRs]), while categorical values are presented as percentages with 95% confidence intervals (CI) when appropriate. The Shapiro-Wilk test was used to assess the normality. Normally distributed continuous variables were compared using Student's t-test. The Mann-Whitney U test was used in the case of variables without normal distribution. The Pearson $\chi 2$ test was applied to all categorical variables. A *P*-value of less than 0.05 was considered statistically significant. To calculate the admission rate for MI (number of admissions per 100 000 inhabitants) we used data provided by the Polish Central Statistical Office [10].

Multivariable, stepwise logistic analysis was used to assess factors independently related to in-hospital mortality. Kaplan-Meier methods were used to construct unadjusted survival curves for each outcome. Cox proportional hazard regression analysis was used to assess the independent predictors of the endpoints. Beginning with all the variables presented in Table 1, stepwise analysis was conducted

Table 1. Characteristics of the analyzed groups.

Variable	Number (%)
Age, years, mean (SD)	68.8 (12.0)
Sex	
Males, n (%)	47420 (62.7)
Females, n (%)	28266 (37.3)
Patients' history	
Hypertension, n (%)	55735 (73.6)
Diabetes, n (%)	23510 (31.1)
Atrial fibrillation, n (%)	9807 (12.6)
Previous stroke, n (%)	2358 (3.1)
Previous myocardial infarction, n (%)	5062 (6.7)
Previous PCI, n (%)	7982 (10.4)
Previous CABG, n (%)	640 (0.8)
Heart failure, n (%)	16675 (22.0)
Chronic kidney disease, n (%)	6345 (8.4)
Neoplasm in the history, n (%)	17058 (22.5)
Chronic obstructive pulmonary disease, n (%)	8283 (10.9)
Index hospitalization	
Coronary angiography, n (%)	66943 (87.9)
PCI, n (%)	54767 (72.4)
CABG, n (%)	3016 (4.0)
Department	
Cardiology, n (%)	65336 (86.3)
Internal medicine, n (%)	7437 (9.8)
Other, n (%)	2913 (3.8)

Values are presented as mean (standard deviation [SD]) or n (%)

Abbreviations: CABG, coronary artery bypass grafting; PCI, percutaneous coronary intervention

using the probability value <0.05. The statistics were calculated with STATISTICA 13 software (TIBCO Software, Palo Alto, CA, US).

RESULTS

A total of 75 868 patients (mean age, 68.8 [12.0] years) were hospitalized for acute MI from January 1, 2018 to December 31, 2018 in Poland, including 47420 men (mean age, 66.3 [11.6] years) and 28266 women (mean age, 73.1 [11.5] years). Admission rates due to myocardial infarction in Poland in 2018 in relation to age and sex are presented in Figure 1. In total, the admission rate was 197.0 per 100 000 inhabitants (255.2/100 000 among men and 142.5/100 000 among women). Overall, 86.3% of patients were hospitalized in a department of cardiology (Table 1).

Most patients were hospitalized in only one hospital (82.6%), while 14.8%, 2.4%, 0.3%, and 0.05% patients were hospitalized consecutively in two, three, four, and at least five hospitals. The median length of hospitalization was 6 (4–9) days, while the mean duration of hospitalization was 8.0 (8.8) days (median 6 [4–9] days). Invasive management (at least coronary angiography) was introduced in 87.9% of patients, percutaneous coronary intervention (PCI) in 72.4%, and coronary artery bypass grafting (CABG) in 4.0% of patients (Table 1).

In-hospital mortality was 8.4% (95% CI, 8.2%–8.6%) and 69 310 patients were discharged alive from the hospital. Figure 2 presents in-hospital mortality by age group. Mortality among patients hospitalized in a department of cardiology was 7.0 (6.8–7.2)%, among those hospitalized in departments of internal medicine the corresponding rate was 15.0 (14.2–15.8)%, and among patients hospitalized in other departments 22.9 (21.3–24.4)%; P <0.001. Among patients hospitalized in one hospital only, mortality was 8.1 (7.9–8.3)%, while among patients hospitalized consecutively in two, three, four, and at least five hospitals mortality was 9.1 (8.5–9.6)%, 14.4 (12.8–16.0)%, 13.7 (9.0–18.5)%, and 28.9 (13.8–44.1)%, respectively. Mortality was 6.4 (6.2–6.6)% in patients managed invasively and 22.9 (22.0–23.7)% in patients managed non-invasively (P <0.001), 6.6 (6.4–6.8)% in patients who underwent PCI, 6.8 (5.9–7.7)% in those who underwent CABG, and 5.7 (5.3–6.2)% in patients who

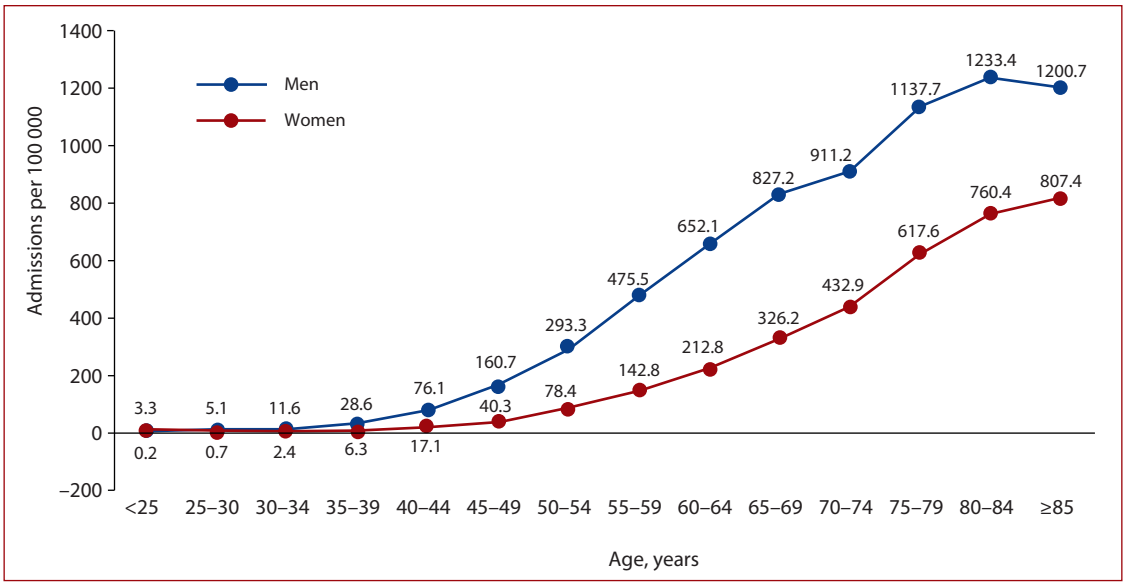

Figure 1. Crude admission rates due to myocardial infarction in Poland in 2018 in relation to age and sex

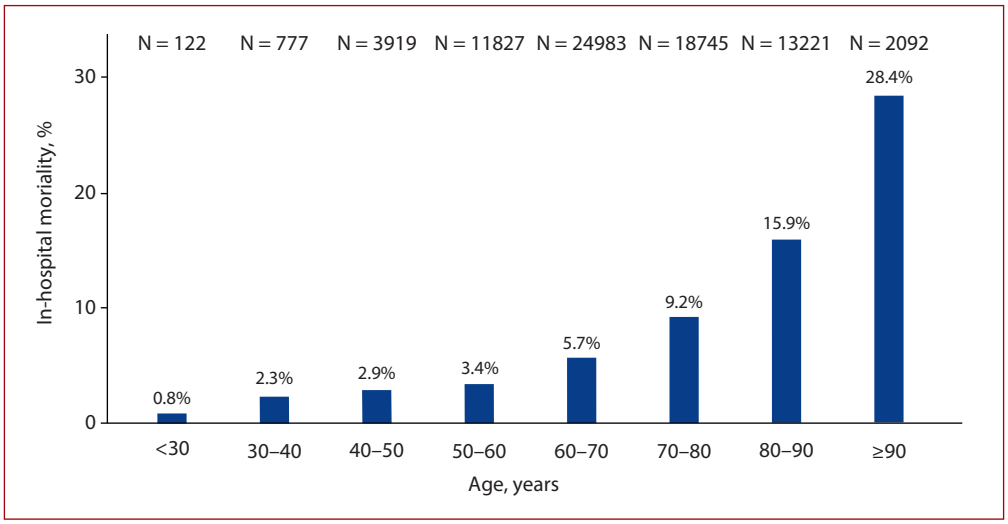

Figure 2. In-hospital mortality by age groups

Table 2. Factors independently related to in-hospital death (n = 75686)

Variable	OR (95% CI)
Age per 10 years	1.61 (1.57–1.65)
Hypertension	0.70 (0.66–0.75)
Diabetes	1.21 (1.14–1.28)
Previous stroke	1.43 (1.27–1.62)
Heart failure	1.24 (1.16–1.32)
Chronic kidney disease	1.31 (1.21–1.42)
Neoplasm in the history	0.78 (0.73–0.83)
Invasive management (at least coronary angiography)	0.40 (0.37–0.43)
Department	
Cardiology	0.37 (0.33–0.41)
Internal medicine	0.44 (0.39–0.49)
Other	1.00

Abbreviations: CI, confidence interval; OR, odds ratio

underwent coronary angiography only (without revascularization procedures). Supplementary material, *Figures S1* and *S2* present in-hospital mortality in patients managed invasively and non-invasively by age groups. Table 2 presents variables independently related to in-hospital mortality.

Overall, 5810 died during the observation period. In addition, the endpoint consisting of all-cause death, MI, or stroke occurred in 9253 patients, while the endpoint consisting of all-cause death or hospitalization for cardiovascular reasons occurred in 27100 patients. One-year all-cause mortality among patients hospitalized for MI (including in-hospital and post-discharge events) was 17.3 (17.0–17.6)%. Figure 3 presents the estimated event-free survival probability following discharge. The proportion of patients suffering from recurrent myocardial infarction within one year following discharge was 7.0 (6.8–7.2)%, the proportion of patients suffering from a stroke was 1.6 (1.5–1.7)%, and the proportion of patients hospitalized at least once for cardiovascular reasons was 40.4 (40.0–40.8)%. One-year death probability following discharge from hospital was 2.2 (1.9–2.6)% among patients aged <55 years, 5.0 (4.6–5.3)% among patients aged 55–65 years, 8.5 (8.1–9.0)% among patients aged 65–75 years, 15.5 (14.8–16.2)% among patients aged 75–85 years, and 27.4 (26.0–28.7)% among those aged ≥85 years. The corresponding proportions for endpoint consisting of all-cause death or MI or stroke were 6.6 (6.0–7.2)%, 10.6 (10.0–11.1)%, 15.0 (14.4–15.5)%, 21.9 (21.1–22.7)%, and 31.3 (29.8–32.7)%, respectively, while for endpoint consisting of all-cause death or hospitalization for any cardiovascular cause: 32.8 (31.7–34.0)%, 39.1 (38.3–40.0)%, 45.8 (45.0–46.6)%, 51.5 (50.5–52.5)%, and 53.3 (51.7–54.9)%. Supplementary material, *Figures S3–S5* present proportions of patients with MI, stroke, and patients hospitalized for cardiovascular reasons by age groups.

The independent predictors of the endpoints are presented in Table 3. About half of discharged patients consulted their general practitioners within 14 days following discharge, while 12% of patients consulted a cardiologist within 30 days following discharge (Figure 4). Overall, 0.06%, 0.14%, 0.27%, 0.33%, and 0.34% of the patients began telerehabilitation within 14, 30, 90, 180, and 365 days of discharge, respectively. The participation rate in any form of cardiac rehabilitation within first the 14 days following discharge was 11% and within the first 30 ways was 19% (Figure 4). In addition, 13% of MI survivors underwent PCI within the first 90 days following discharge, 2.5% underwent CABG within 180 days, and 1.9% had an implantable cardioverter-defibrillator implanted within 365 days following discharge (Figure 5).

DISCUSSION

This countrywide analysis included data on all patients hospitalized for acute MI in Poland in 2018. The main strength of our study is the fact that we analyzed all patients who had the Polish personal identification number and whose hospitalization for MI had been reported to the National

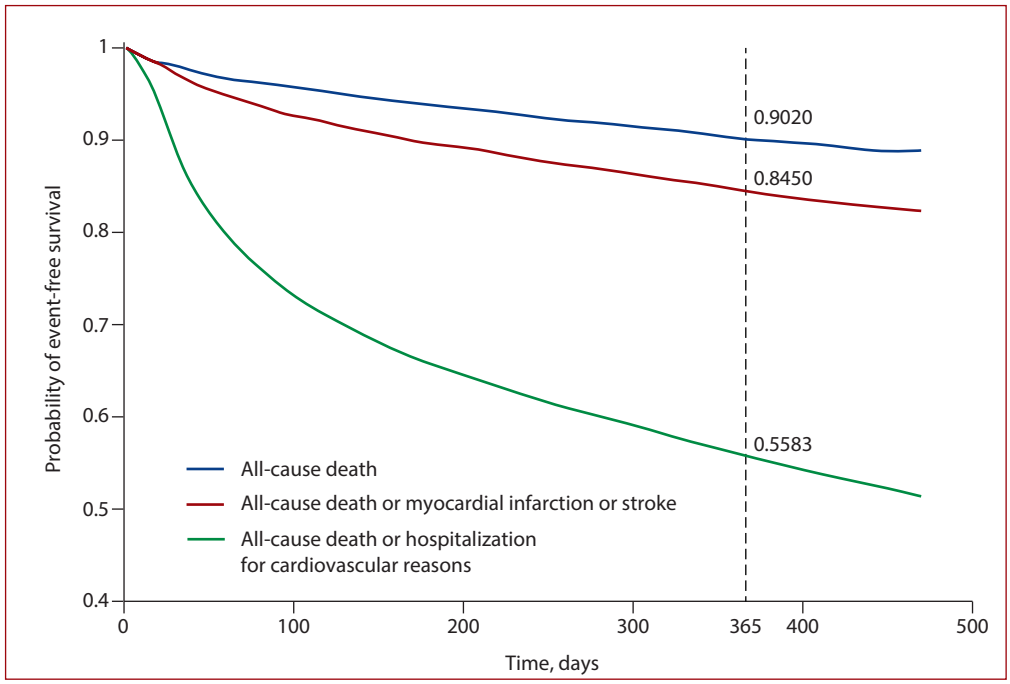

Figure 3. Kaplan-Meier curves displaying the estimated event-free survival probability

Table 3. Independent predictors of all-cause death, all-cause death or myocardial infarction or stroke, and all-cause death or hospitalization for cardiovascular reasons following discharge (n = 69310)

Variable	HR (95% CI)		
	All-cause death	All-cause death or myocardial infarction or stroke	All-cause death or hospitalization for cardiovascular reasons
Age per 10 years	1.62 (1.57–1.66)	1.34 (1.31–1.37)	1.13 (1.12–1.14)
Sex			
Female	1.0	1.0	1.0
Male	1.21 (1.14–1.28)	1.19 (1.14–1.25)	1.18 (1.15–1.21)
Hypertension	0.82 (0.76–0.88)	—	—
Diabetes	1.22 (1.15–1.29)	1.22 (1.17–1.28)	1.09 (1.06–1.12)
Atrial fibrillation	1.08 (1.01–1.15)	—	1.07 (1.03–1.11)
Previous stroke	1.61 (1.45–1.79)	1.60 (1.47–1.75)	1.15 (1.08–1.23)
Previous myocardial infarction	—	1.19 (1.09–1.29)	—
Previous PCI	—	1.15 (1.06–1.23)	1.08 (1.04–1.12)
Previous CABG	0.73 (0.55–0.97)	—	—
Heart failure	1.59 (1.49–1.69)	1.46 (1.39–1.53)	1.20 (1.17–1.24)
Chronic kidney disease	1.41 (1.32–1.52)	1.30 (1.23–1.38)	1.19 (1.14–1.24)
Neoplasm in the history	1.15 (1.09–1.22)	1.11 (1.06–1.16)	—
Chronic obstructive pulmonary disease	1.28 (1.19–1.37)	1.10 (1.04–1.17)	1.07 (1.03–1.11)
Invasive management (at least coronary angiography) during index hospitalization	0.60 (0.56–0.65)	0.65 (0.61–0.69)	0.82 (0.78–0.85)
PCI during index hospitalization	0.68 (0.64–0.73)	0.87 (0.83–0.92)	1.08 (1.05–1.12)
CABG during index hospitalization	0.51 (0.42–0.61)	0.58 (0.50–0.67)	0.79 (0.74–0.85)
Hospitalization in a department of cardiology	0.52 (0.48–0.59)	0.67 (0.61–0.73)	0.85 (0.82–0.88)
Hospitalization in a department of internal medicine	0.68 (0.61–0.76)	0.84 (0.76–0.93)	—

Abbreviations: CABG, coronary artery bypass grafting; HR, hazard ratio; PCI, percutaneous coronary intervention; other — see Tables 1 and 2

Health Fund database. We found that in 2018, 75 868 patients were hospitalized for acute MI in Poland. This means a decrease in the number of patients hospitalized for MI by 3532 (about 4.4%) compared to 2012 [3]. Several possible factors may have led to a reduction in the number of patients admitted for MI: the revised definition of MI, changed habits of physicians in diagnosing and reporting MI, an increase in the prescription rate of cardiovascular drugs in patients with established coronary artery disease, as well as improvements in the control of main cardiovascular risk factors in the general Polish population [11–15]. A gradual decrease in the admission rates for MI in Poland from 2009 to 2012 was shown previously [3]. We could not analyze patients who died outside the hospital due to MI,

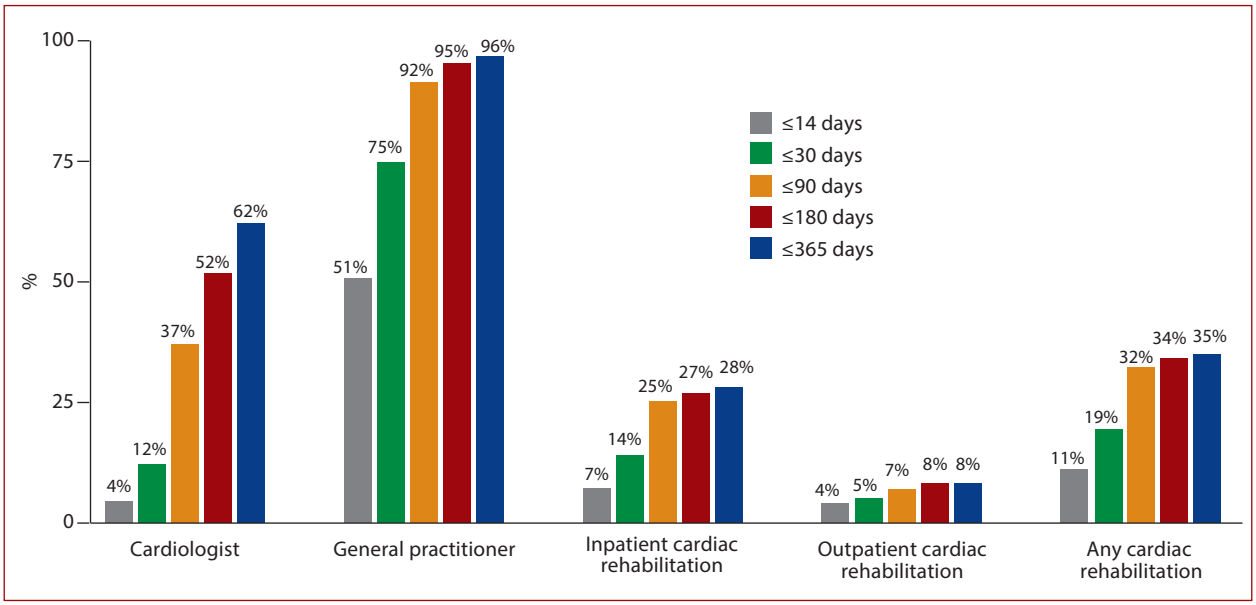

Figure 4. Cumulative proportions of patients consulted by a cardiologist, a general practitioner, and starting a cardiac rehabilitation programme by number of days following discharge

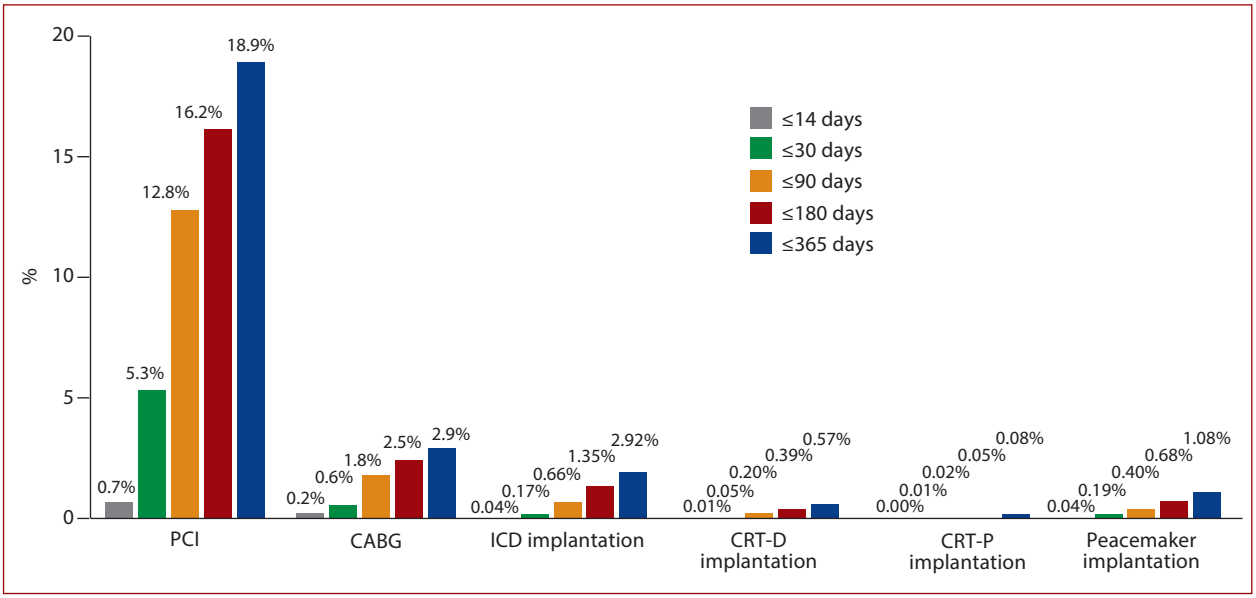

Figure 5. Cumulative proportions of patients undergoing selected invasive procedures by number of days following discharge

Abbreviations: CRT-D, cardiac resynchronization therapy defibrillator; CRT-P, cardiac resynchronization therapy pacemaker; ICD, implantable cardioverter defibrillator; CABG, coronary artery bypass grafting; PCI, Percutaneous coronary intervention

before their admission to the hospital. The proportion of patients who died outside the hospital due to MI among all cases of MI in 2012 was estimated to be 6.6% [3]. If we apply this figure to our data, we could estimate the number of patients suffering from MI in 2018 to be about 81250. The admission rates increase with age in men and women, but the increase was steeper in women, although the admission rate was higher among men in every age group. These relations agree with the previous findings [3].

In-hospital mortality among patients hospitalized for MI was 8.4% in 2018. This estimate is considerably lower compared to 2009–2010 [3, 13]. This reduction may be due to improvements in the management of patients with acute MI, including an increase in the proportion of patients undergoing coronary angiography (from 72.5% in 2009 to 87.9% in 2018), percutaneous coronary intervention (from 59.1% to 72.4%), and coronary artery bypass grafting (from 1.9% to 4.0%) [3]. Other factors, such as progress in the pharmacotherapy of MI patients or better organizational standards of pre-hospital and in-hospital medical care, may also have played a significant role [12, 13].

The diagnosis of hypertension was not related to increased mortality in our analysis. The previous scientific evidence is contradictory: some studies show increased

risk among postinfarction patients with hypertension, some show no significant association between hypertension and mortality, while some analyses show even higher mortality among patients with low blood pressure [14–15]. It is possible that in some cases the lack of diagnosis of hypertension may be a marker of heart failure or other systemic, severe disease. Age, sex, diabetes, atrial fibrillation, stroke, heart failure, chronic kidney disease, chronic obstructive pulmonary disease, management in the acute phase of MI, and hospitalization in cardiology and general medicine departments were all independently related to the risk of the endpoints.

The estimate for 2009 suggested one-year mortality following discharge at a level of 10.1% [3]. We found one-year all-cause mortality to be slightly lower, although the cohort of MI survivors in 2018 was approximately 1.4 years older compared to patients discharged in 2009 and 2010 [13]. Although the prescription rate for cardiovascular drugs in patients with established coronary artery disease increased a high proportion of patients following MI still have cardiovascular risk factors uncontrolled [15, 16]. Indeed, only 2.3% of patients with coronary artery disease, including those after MI, had all the main risk factors well-controlled [24]. Furthermore, a significant increase has been observed in the proportion of coronary patients with obesity and diabetes in Poland [17]. Moreover, most patients still do not participate in cardiac rehabilitation programs, and only 37% of MI survivors consulted a cardiologist within 90 days of their discharge. It has been shown that patients who consulted a cardiologist have a lower risk of death compared to those consulted by a general practitioner alone [18].

The main healthcare payer in Poland is the National Health Fund. In the case of hospitalizations and procedures related to acute MI treatment, the National Health Fund is virtually the only payer that signs contracts with public and private healthcare providers. Therefore, the underestimation of the number of patients hospitalized for MI is not probable. On the other hand, some post-infarction patients could consult cardiologists omitting the National Health Fund system. Indeed, every tenth patient hospitalized for coronary artery disease consulted a cardiologist after discharge from the hospital [19].

Importantly, the recently launched MAnaged Care for Acute Myocardial Infarction Survivors (MACAMIS) system has been accompanied by increased access to early cardiac rehabilitation (odds ratio of starting cardiac rehabilitation within the first 14 days following discharge was 16.89), cardiac consultations (odds ratio of cardiac consultation within first 6 weeks following discharge was 7.28), and a lower risk of death and cardiovascular events [20, 21]. The improved concordance could also improve the MI survivors' prognosis. Our results suggest considerable potential for a further decrease in mortality in patients suffering from MI in Poland.

Limitations

The present analysis has some limitations. Firstly, this is a cohort study. Hence, only a statistical association rather than any causal relationships could be confirmed. Secondly, we were unable to analyze patients' lifestyles or the prescription rates for cardioprotective drugs. The inclusion of such data in the present analysis could have increased the impact of our results. Thirdly, we had no access to data on the utilization of fibrinolysis in the acute phase of myocardial infarction. However, the proportion of patients with acute MI administered fibrinolysis in 2009 in Poland was 1% [3]. One could expect an even lower proportion in 2018 as the utilization of invasive management increased significantly. Finally, the present results are based on the robustness of the public databases we used. Moreover, the database used in this study was an administrative registry, created mainly to reimburse medical procedures, which provided a limited number of clinical variables available for analysis. The diagnoses of MI and co-morbidities were not externally verified. In addition, we had no access to data on migration. Some patients may have emigrated from Poland and were lost to follow-up. On the other hand, a major advantage of the present study is the analysis of a large, nationwide database covering virtually all patients hospitalized for MI in 2018 in Poland. Thus, the data regarding therapy, readmissions, and deaths provide a summary of current everyday clinical practice and its outcomes.

CONCLUSION

The in-hospital and post-discharge mortality in patients suffering from MI in Poland, though lower than in the first decade of the 21st century, is still high. Access to cardiac consultations and cardiac rehabilitation following myocardial infarction is insufficient. There is considerable potential for a further decrease in mortality in this population of patients.

Supplementary material

Supplementary material is available at https://journals.viamedica.pl/kardiologia_polska.

Article information

Conflict of interest: None declared.

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